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ABSTRACT

This lesson deals with special considerations that should be made when choosing a sludge solids management program, briefly describing the source of solids in wastewater and why they must be dealt with. The various solids handling processes and ultimate disposal methods are also briefly described, followed by a detailed discussion of the technical criteria and social/economic criteria that must be considered when selecting a program. The lesson includes an instructor's guide and student workbook. The instructor's guide contains a description of the lesson, estimated presentation time, instructional materials list, suggested sequence of presentation, reading lists, objectives, lecture outline, narrative of the slide/tape program used with the lesson, and student worksheet (with answers). The student workbook contains objectives, text material on planning considerations, references, and worksheet. (JN)

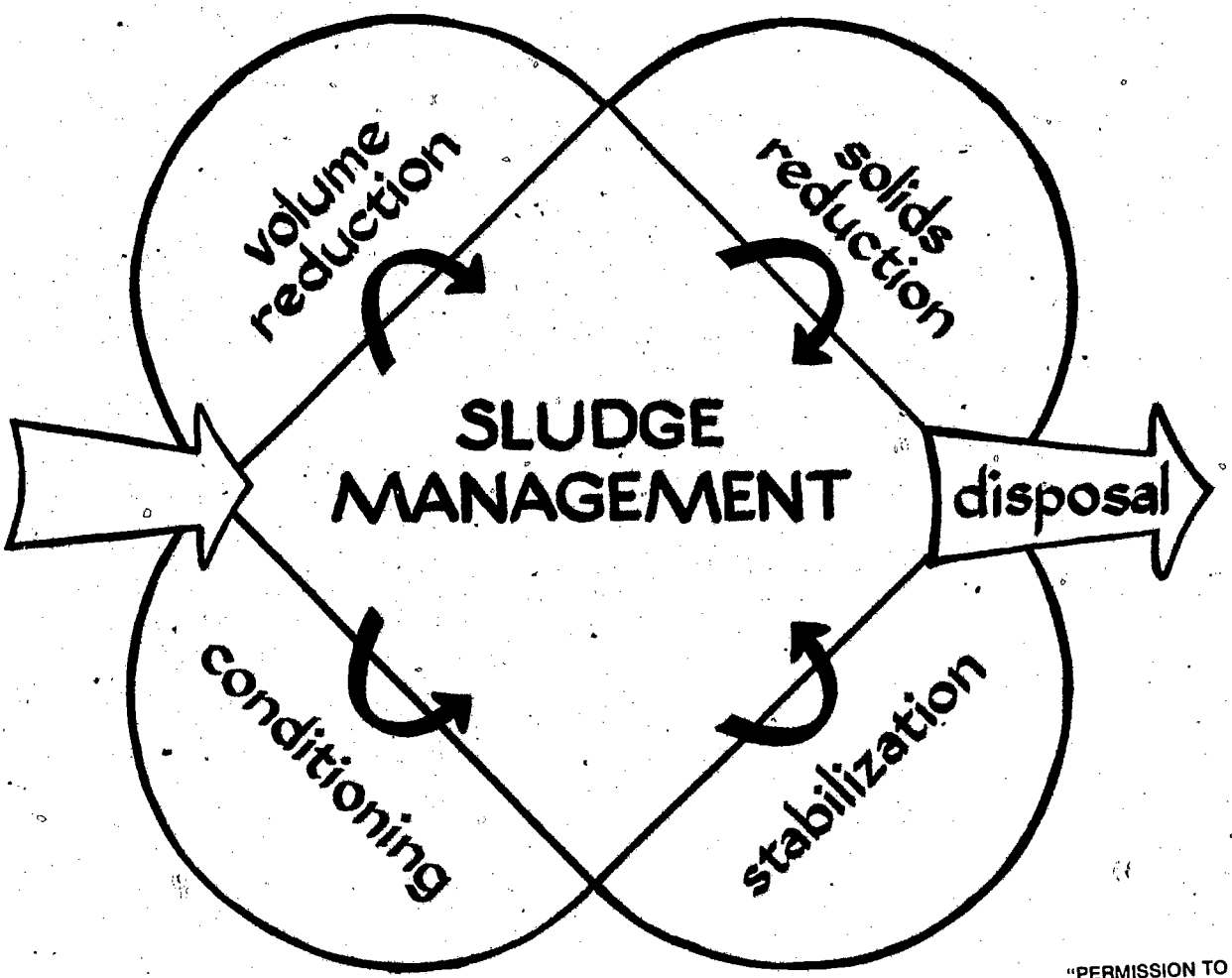
SLUDGE TREATMENT

and

DISPOSAL

COURSE # 166

PLANNING CONSIDERATIONS



INSTRUCTOR'S GUIDE

Prepared by
Linn-Benton Community College
and
Envirotech Operating Services

PLANNING CONSIDERATIONS

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PLANNING CONSIDERATIONS

CONTENTS

PLANNING CONSIDERATIONS

Lesson Description

This lesson deals with the special considerations that should be made when choosing a sludge solids management program. The lesson briefly describes the source of solids in wastewater and explains why they must be dealt with The various solids handling processes and ultimate disposal methods are explained very briefly. The technical criteria and many social and economic criteria that must be considered when selecting a program are then discussed in detail.

Estimated Time

Student preview of objectives	5-10 minutes
Presentation of material	20-30 minutes
Worksheet	10 minutes
Correct worksheet and discussion	10 minutes

Instructional Materials Listed

1. Student text, "Planning Considerations"
2. Slide/tape set, "Planning Considerations"
3. Slide Projector, 35mm
4. Tape player with synchronization to projector
5. Screen

Suggested Sequence of Presentation

1. Assign students to read objectives in class
2. Show slide/tape program
3. Carry on open discussion
   a. Answer any technical questions regarding processes first. Be simple and brief.
   b. Direct discussion toward examples of social and economic criteria.
   c. Emphasis needed to weigh all aspects and select an integrated system.
4. Assign worksheet
5. Correct worksheet

Required Reading

Student text material, "Planning Considerations"

Reference Reading

"Process Design Manual for Sludge Treatment and Disposal" Chapters 2 and 3. U.S. EPA, September, 1979, EPA 625/1-79-011.

Objectives

Upon completion of this lesson the student should be able to do the following:

1. Recall that the three major types of solids are raw, biological and chemical solids.
2. Give three of the five solids reduction processes.
3. Give three of the five sludge conditioning or stabilization processes.
4. Give six of the nine volume reduction processes.
5. Give the three ultimate disposal methods.
6. Explain "systems approach" to the design of solids handling systems.
7. Recall that a new solids handling system must have a site available, that the system must be legal, and that financing must be assured.
8. Give two examples of existing programs with which a new solids handling system must be compatible.
9. As they relate to solids handling systems, give an example of each of the following: a direct cost, an indirect cost, a direct benefit and an indirect benefit.
10. As they relate to solids handling systems, give an example of a direct energy demand, an indirect energy demand and an energy recovery process.
11. Give an example of an adverse impact which a solids handling system would have on public health.
12. As they relate to solids handling systems, give an example of one adverse and one beneficial effect on soil.
13. Give an example of an adverse effect which a solids handling system could have on each of the following: water quality, air quality and the plant and animal life.
14. As they relate to solids handling systems, give an example of one adverse and one beneficial social effect.
15. Give an example of a public safety problem which could result from a solids handling system.
16. Give three examples of increased administrative burdens which could result from a new solids handling system.

PLANNING CONSIDERATION

LECTURE OUTLINE

I. THE SOURCE OF THE SOLIDS PROBLEM

A. We Use Water In Many Ways

1. To drink
2. To prepare food
3. To wash ourselves, dishes, clothes
4. To clean street
5. To wash cars
6. To put out fires
7. In industry
8. In Science
9. In recreation
10. In agriculture
11. And many other ways

B. Solid Matter Added To Water As It Is Used

1. Dissolved
2. Suspended

C. Removal Of These Solids Is A Major Task Of Every Wastewater Treatment Plant

II. TYPES OF SLUDGE PRODUCED

A. Raw Sludge - Solids Heavy Enough To Settle Out During Primary Clarification

B. Biological And/Or Chemical Treatment

1. Convert fine, suspended and dissolved solids to settleable sludge
2. Biological sludge
3. Chemical sludge

III. SLUDGE HANDLING AND TREATMENT A BIG TASK

A. About ¼ lb. Per Person Per Day

B. Six Tons Per Day For A Community Of 50,000

IV. THE SLUDGE MANAGEMENT PROGRAM

A. Can Be One Or A Combination Of Processes

1. Sludge volume reduction
2. Sludge solids reduction
3. Stabilization
4. Conditioning

B. Processes Followed By Ultimate Disposal

V. THE PROCESSES

A. Sludge Volume Reduction

1. Purpose - to concentrate sludge solids by removing water
2. Gravity thickening
3. Centrifugation
4. Flotation thickening
5. Belt filtration
6. Vacuum filtration
7. Gravity concentration
8. Filter press
9. Drying beds

B. Conditioning

1. Purpose - pretreatment of sludge to enhance sludge volume reduction
2. Chemical
3. Heat
4. Elutriation, and others

C. Stabilization

1. Purpose - make the sludge less odorous and putrescible and reduce pathogenic organism content

2. Lime

3. Chlorine

D. Sludge Solids Reduction

1. Purpose - decrease the amount of suspended solids in the sludge

2. Anaerobic digestion

3. Aerobic digestion

4. Sludge lagoons

5. Composting

E. Several Processes Carry Out Several Functions

1. Anaerobic and aerobic digestion

also stabilizes and reduces volume

2. Sludge lagoons

also stabilizes and reduces volume

3. Composting

also stabilizes

VI. ULTIMATE DISPOSAL

A. Land Application

B. Landfill

C. Incineration

VII. CHOOSING A SLUDGE MANAGEMENT PROGRAM

A. Choice Must Be Made With Technical, Social And Economic Considerations

B. The Systems Approach Must Be Used

1. The solids management program must be an integral part of the overall wastewater treatment system

C. Technical Criteria

1. Treatment process must be suitable for type of waste being treated
2. Do not choose on technical criteria alone
3. Advantages and disadvantages from a technical standpoint discussed in other modules.

D. Social And Economic Criteria

1. Site availability
2. Legal restrictions
3. Economic realities
4. Compatibility with other programs
5. Economic impact
   a. Direct positive
   b. Indirect positive
   c. Direct negative
   d. Indirect negative
6. Energy
   a. Direct demand
   b. Indirect demand
   c. Recovery
7. Public health and safety
8. Air quality problems
9. Water quality problems
10. Air, water, and soil quality impact on animal life
11. Administrative burdens
    a. Changes in operation, staffing, scheduling
    b. Safety programs
    c. Training programs

E. Selection Of Program Must Be A Community Effort

1. Good planning can mean a well-accepted program
2. Must involve planners, engineers, operators, legal advisors and citizens .
3. All criteria must be considered
4. Give and take until each piece of the sludge management program fits into the total picture

NARRATIVE

Slide #

1. This Planning Considerations module briefly describes the various sludge handling processes and discusses the many factors which should influence the selection of a solids handling system.

2. This module was written by Dr. John W. Carnegie. The instructional development was done by Priscilla Hardin. Mr. Paul Klopping was the Project Director.

3. In nearly every phase of our daily activities, we use water. We use water to prepare food, to wash dishes and clothes, to drink, to clean streets, to wash cars and to put out fires. We use water in industry, in science, in farming and in recreation.

4. As water is used, it becomes less usable and must be treated to return it to a usable form. Wastewater treatment is an essential part of man's use of water. In treating wastewater, we are protecting the environment and conserving one of our most important resources.

5. As water is used, a great deal of solid matter is added to it. Some solids are dissolved in the water and some remain suspended. The removal of these solids in the form of settleable sludge is an important part of every wastewater treatment plant's operation. Solids can be removed as raw sludge, biological sludge, or as chemical sludge.

6. A large percentage of solids in wastewater is heavy enough to settle out during primary clarification. When these solids settle out, they are referred to as raw sludge.

7. Solids that do not readily settle out, dispersed solids, and those that are dissolved may be subjected to biological or chemical treatment processes. These processes increase the settleability of the dissolved and dispersed solids. In both processes, the solids tend to increase in size and mass in process called flocculation until they are big enough and heavy enough to form a settled sludge.

8. In the biological process, bacteria convert the dissolved and suspended matter to new cells referred to as biological floc. The wastewater is then free of most of the dissolved and suspended matter and the settled biological floc can be removed as biological sludge.

9. In the chemical process, floc is formed by adding chemicals to the dispersed solids. The wastewater is then free of the dispersed solids and the settled floc can be removed as chemical sludge.

10. Raw, biological and chemical sludges must be dealt with in the overall wastewater treatment system. The sludge handling portion of a treatment systen is no small item. For an average biological treatment process, about 0.25 lbs of dried sludge must be disposed of for each person a day. For a community of 50,000, that means better than 6 tons per day must be dealt with.

11. A sludge management program can be a combination of treatment processes, ending in disposal. The various sludge treatment processes are designed to carry out one or more of the following: Volume reduction, solids reduction, conditioning, and stabilization.

12. The purpose of sludge volume reduction is to concentrate the sludge by separating some of the water from the sludge. After the sludge is concentrated, it can be further treated in less volume. The following processes are used primarily for sludge volume reduction.

13. Gravity thickening is similar to sedimentation in that the sludge is allowed to settle under the influence of gravity. Concentrated sludge is collected off the bottom and water is removed from the surface.

14. Centrifugation takes advantage of centrifugal force. As the sludge is spun in the centrifuge, the sludge is forced to the outside and the water removed near the center.

15. flotation thickening separates the sludge from water by bubblin air into the sludge to decrease sludge density. With the air bubbles trapped in the sludge, it floats to the surface where it is scraped off. Water is removed from one end of the basin over a protected weir.

16. Belt Filtration, Vacuum Filtration, Filter Pressing and Gravity Concentration are all devices that remove the water from the sludge with a filitering action. Some of these systems use a vacuum to such the water through the filter and away from the sludge. Some squeeze the liquid out through the filter and away from the sludge. Some squeeze the sludge into cakes between porous mats. The gravity concentration process use gravity to pull water through a porous mat and away from the sludge. In all cases, the sludge becomes more concentrated, reducing the total volume.

17. Heat can also be used to reduce sludge volume. Drying beds use heat from the ambient air or the sun to evaporate the water from the sludge. Low temperature hear can also be applied to speed the evaporation process. Underdrain systems are used to remove water that seeps out the bottom of the drying sludge.

18. A second major sludge treatment category is conditioning. Conditioning is defined as the pretreatment of sludge to enhance sludge volume reduction. The processes of gravity thickening, flotation thickening, vacuum filtration, centrifugation, drying beds and filter presses, can all be made more efficient with sludge conditioning.

19. Sludges can be conditioned by the addition of chemicals, by heat or elutriation. Organic polyelectrolytes as well as inorganic chemicals can be used to condition sludge. In the heat conditioning process, sludge is subject to high temperatures and pressure. In both processes, the chemical and physical structure of the sludge is altered in such a way as to make the removal of water easier. Elutriation conditions by a washing process which reduces chemical requirements and removes fine sludge particels.

20. The primary purpose of stabilization is to make the sludge less odorous and putrescible and reduce pathogenic organism content.

21. The addition of lime to sludge in quantities sufficient to raise the pH to about 11.0, will stabilize the sludge and destroy pathogenic bacteria. Chlorine stabilizes by lowering the pH and by oxidation.

22. The last major sludge treatment category is sludge solids reduction. Several treatment processes result in a decrease in the suspended sludge solids. Reduction of the solids present will, of course, mean that a smaller amount must be disposed of in the end.

23. Both anaerobic and aerobic digestion result in sludge solids reductions.

24. The anaerobic process takes place in a covered vessel in which the oxygen-free anaerobic condition is maintained. Sludge is usually warmed and stirred as the anaerobic bacteria methabolize and reduce the solids content. Stabilization and sludge volume reduction also occur.

25. The aerobic digestion process is similar to an activated sludge treatment process. It is an aerobic biological process carried out in an open basin. The aerobic bacteria metabolize and reduce the solids content. Stabilization and sludge volume reduction also occur with the aerobic process.

26. Sludge lagoons can be utilized to reduce sludge solids. In biological processes similar to wastewater stabilization ponds, stored sludge can be metabolized and the solids content reduced. In addition, sludge volume reduction can also occur.

27. Composting of sludges can result in a reduction of the sludge solids, as well as sludge stabilization. The total volume of composted material is greater than the original sludge volume, however, because bulking material is usually added to enhance aeration and digestion. The compost is allowed to digest for about two weeks, with occasional mixing.

28. Regardless of the type of conditioning, volume reduction, solids reduction or stabilization process used, there is still the problem of ultimate disposal of the treated sludge.

29. After treatment, sludge can be applied to land as a soil conditioner, it can be buried in landfill sites, or it can be reduced to ash by incineration. Land application is usually limited to agricultural crop land not used directly for food crops such as vegetables. Strict regulations govern its application. Common solid waste landfills are often used as an ultimate disposal site. The major drawback to landfill is that no benefit is derived from the sludge. Incineration also destroys the sludge and is a high, energy requiring process.

30. A sludge management program could be composed of different combinations of these processes. The decision of which processes to select must be made with many technical, social and economical factors taken into consideration. Whatever the choice, the "systems approach" must be the prime consideration. This means, simply, that the solids management program must be part of the system, and not be considered a separate entity or sideline.

31. From a technical standpoint, the type of waste being treated must be considered in the selection of the type of treatment and the type of equipment and facilities. The specific advantages and disadvantages of the various processes, from a technical viewpoint, and the equipment and facilities required for the various processes, are discussed in later modules.

32. However, the sludge management program should not be selected on the basis of technical criteria alone. The sludge management program will have a significan social and economic impact on the community and it is important that criteria based on these social and economic impacts also be considered.

33. Social and economic criteria should include consideration of a number of items. Let's discuss each of these indifidually.

34. Site availability for the new system must be carefully considered. Location for the treatment units, as well as ultimate disposal locations, are important. Should the solids handling units be located at the treatment plant? Is ownership clear or must land be obtained? Location with respect to residential areas may be a problem.

35. The solids management program as a whole must, of course, be legal. A thorough understanding of the restrictions on ultimate disposal, air emission and water discharges is necessary.

36. The financing of the system must be assured. The sources of funding such as local tax, bonds, state and federal grants, should be investigated so that economic realities are clear during the selection process.

37. The new system should be compactible with existing programs such as land use planning and zoning, regional wastewater, solids and air pollution control programs and existing treatment facilities. Compatibility will insure greater acceptance of the system and usually be considerably more economical.

38. The economic impacts of a new system on a community can be both direct and indirect and have both a negative and a positive effect.

39. Direct negative effects would be cost of site acquisition and capital investment.

40. Indirect negative impact might be decreased land value near the site, loss of private property, or job loss due to imcompactibility with existing industry or agriculture.

41. Direct positive impact can come from construction money to local contractors, payroll to operations personnel and sales of private land.

42. Indirect positive impact can come from construction and payroll monies affecting the economics of the entire community, recreational and commercial use of protected waterways, and increased land productivity due to solids application.

43. All of the economic factors should be considered in <u>balance</u>, as the various alternatives are reviewed.

44. Energy demand and energy recovery is a serious social and economic concern. Direct energy demands include electric power, gas and oil consumption for operations of the facilities, as well as construction.

45. Indirect energy demands include energy to produce chemicals and for transportation.

46. Some of the solids handling processes have energy recovery potential such as the production of natural gas in the anaerobic digestion process or the heat produced by incineration. The choice of process must balance energy demand with desired results.

47. Public health and safety must be considered both during construction and later during normal operations. For example, would sludge trucks pass through residential areas or near schools? Landfill and land application areas must have restricted access because of potential health problems. The potential for contamination of potable water sources must be considered.

48. Application of treated sludge onto land can have both adverse and beneficial effect on the soil. The productivity of soil can be improved by the chemical content of sludge applied to the land. However, some types of sludges contain chemicals which can change pH values and nutrient balance in the soil and, in some cases, be toxic to vegetation and animals.

49. Some of the solids handling processes pose potential threats to water and air quality and to plant and animal life. If processes are located where leaching and runoff from lagoons, landfills, and composting can reach lakes and streams, water quality can be hurt.

50. Air quality becomes an issue with incineration and the other heat treatment processes.

51. Animal and plant life, both terrestrial and aquatic, can be adversely affected by reduced air and water quality near treatment facilities. Adverse effects on air, water, plants, and animals can be nearly eliminated by careful planning.

52. A solids handling program can have social effects on the community, both adverse and beneficial. If the community feels a need and a desire to protect the environment, the facility and program will be a source of civic pride. Added jobs, both directly and indirectly, can raise standards of living.

53. However, if the community is not involved in planning and if economics and social factors have not been considered, the community may be damaged by forcing acceptance of an unpopular program.

54. Any new program will result in additional administrative responsibilities. Consideration should be given to handling public relations, resolution of legal disputes, and marketing problems. Processes that are compatible with existing administrative structure and required minimal change should be carefully considered.

55. There are several administrative functions that will change or increase. The new sludge handling program will mean changes in operational strategies and require additional staffing and rescheduling. Additional equipment and facilities will increase maintenance needs and, thus, cause changes in maintenance scheduling and staffing.

56. A major concern in the wastewater industry is in-plant safety. Safe operating procedures must be explained at special or regularily scheduled safety meetings. The use of new equipment must be demonstrated. New hazard signs and warning devices must be installed.

57. A new sludge management program will represent concepts and operational skills with which most of the operators are unfamiliar. Training must be provided for new employees and also to up-grade existing employees. An extensive initial training program may be needed to present fundamentals as well as explanations of the new processes.

58. A critical part of the sludge management program is a standby or emergency alternative sludge handling plan. The ability to treat and dispose of sludge is absolutely essential to continued operation of the rest of the treatment system. Therefore, in the event of a breakdown or other operational failure in the primary sludge handling system, an alternative must be available to temporarily handle sludge.

59. In summary, the criteria that should be considered in planning a sludge management program include social and economic considerations as well as technical feasibility.

60. Planners must consider all criteria for process selection in developing the sludge management program, but must not lose sight of the systems approach to the total treatment program.

61. Putting together the sludge management program is a complex process which must involve planners, engineers, operators, legal advisors, and citizens. All criteria must be considered and evaluated so that each piece of the sludge management program will fit into the total picture.

PLANNING CONSIDERATIONS

WORKSHEET

1. Which of the following is NOT one of the three major types of solids found in wastewater treatment plants?

   X a. Suspended

   ____ b. Chemical

   ____ c. Raw

   ____ d. Biological

2. The "systems approach" to the design of a solids handling system means:

   ____ a. That a "systems analyst" using computer based design will always give the best results.

   X b. That the solids handling portion must be part of the overall waste treatment system.

   ____ c. That with any wastewater plant design, the approaching collection systems are the key issue.

3. Match the following examples with their appropriate social or economic criteria. (Some may have more than one answer.):

   1 a. City owned land near existing plant

   4 b. City zoning restrictions

   2 c. Air quality restrictions near residential area

   5 d. Sludge truck route on busy city streets

   3 e. Federal cost sharing for capital construction

   4 f. Regional water quality program applicable

   1. Site Availability
   2. Legal Consideration
   3. Financing Availability
   4. Compatibility With Other Programs
   5. Public Health and Safety

4. Match the following sludge handling processes with their function. (Some may have more than one function.):

4	a.	Anaerobic Digestion
1	b.	Elutriation
5	c.	Landfill
3	d.	Vacuum Filtration
1	e.	Heat Treatment
4	f.	Sludge Lagoon
4	g.	Composting
3	h.	Gravity Thickener
5	i.	Land Application
3	j.	Dissolved Air Flotation
3	k.	Belt Filter
1	l.	Chemical Treatment
2	m.	Lime Addition
3	n.	Filter Press
3	o.	Flotation Thickener
5	p.	Incineration
3	q.	Centrifugation
3	r.	Heat Drying
4	s.	Aerobic Digestion
3	t.	Drying Beds
2	u.	Chlorine Addition
3	v.	Gravity Concentration

1. Conditioning
2. Stabilization
3. Volume Reduction
4. Solids Reduction
5. Ultimate Disposal

5. Match as with #4 above.

2	a.	Decreased land value because of landfill location
3	b.	Payroll increase to community
7	c.	Boiler fired by heat from incinerator
5	d.	Power consumption use to run motors and lights
1	e.	Cost of land acquisition
6	f.	Power consumption used to produce chlorine
4	g.	Increase productivity of agricultural land because of land application
1	h.	Fuel required to haul sludge

1. Direct Cost
2. Indirect Cost
3. Direct Economic Benefit
4. Indirect Economic Benefit
5. Direct Energy Demand
6. Indirect Energy Demand
7. Energy Recovery

6. Match as with #'s 4 & 5 above.

6	a.	Citizen revolt because of "smelly" design
2	b.	"Conditioner" value of sludge from land application
3	c.	Leaching into stream from landfill
4	d.	Excessive stack discharge from incinerator
1	e.	Heavy toxic metals in land applied sludge
8	f.	New training program needed
7	g.	"Good feelings" due to keeping a clean environment
5	h.	Noxious fumes affecting vegetation and animal habitat
8	i.	Change in operation and scheduling

1. Adverse Effect on Soil
2. Beneficial Effect on Soil
3. Adverse Effect on Water Quality
4. Adverse Effect on Air Quality
5. Adverse Effect on Plant & Animal Life
6. Adverse Social Effect
7. Beneficial Social Effect
8. An Administrative Responsibility

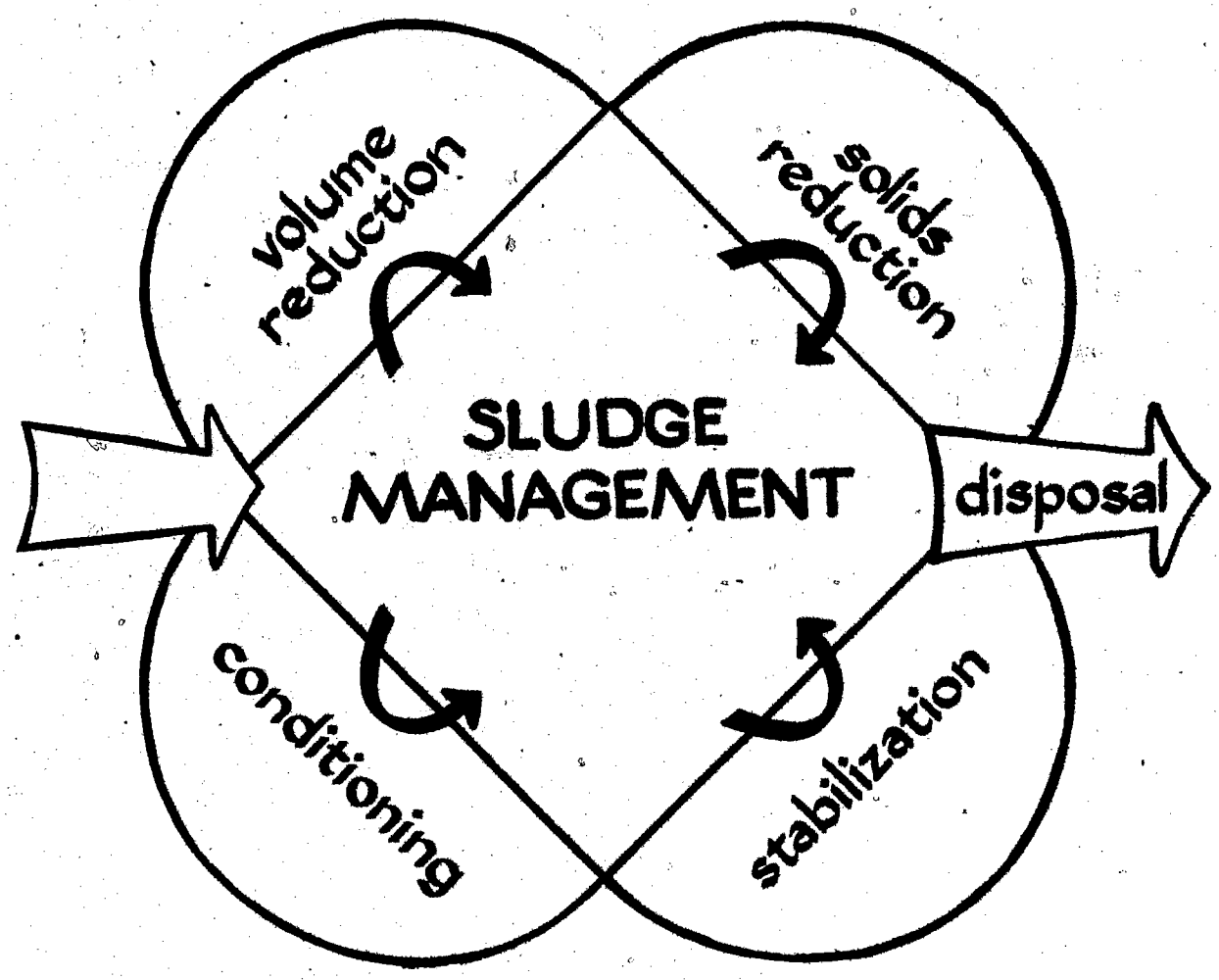
SLUDGE TREATMENT

and

DISPOSAL

COURSE # 166

PLANNING CONSIDERATIONS



STUDENT WORKBOOK

Prepared by
Linn-Benton Community College
and
Envirotech Operating Services

PLANNING CONSIDERATIONS

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PLANNING CONSIDERATIONS

. . . in sludge treatment and disposal

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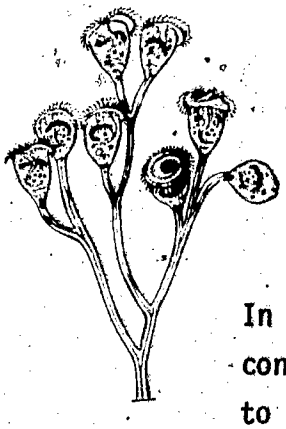
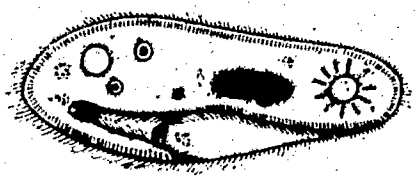
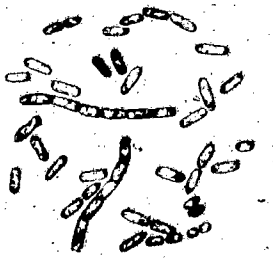
FLOCCULATION Solids that do not readily settle out, dispersed solids, and those that are dissolved may be subjected to biological or chemical treatment processes. These processes increase the settleability of the dissolved and dispersed solids. In both processes, the solids tend to increase in size and mass in a process called flocculation until they are big enough and heavy enough to form a settled sludge.



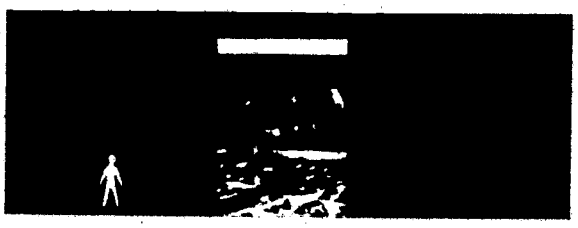


BIOLOGICAL ACTION

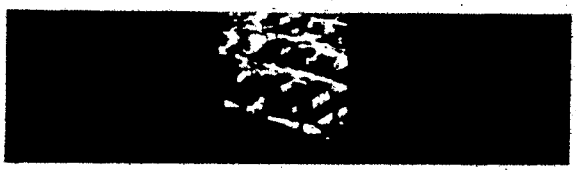


In the biological process, bacteria convert the dissolved and suspended matter to new cells referred to as biological floc. The wastewater is then free of most of the dissolved and suspended matter and the settled biological floc can be removed as biological sludge.

CHEMICAL TREATMENT In the chemical process, floc is formed by adding chemicals to the dispersed solids. The wastewater is then free of the dispersed solids and the settled floc can be removed as chemical sludge.



1/4 lb. x 50,000 = 6¼ tons per day



Raw, biological and chemical sludges must be dealt with in the overall wastewater treatment system. The sludge handling portion of a treatment system is no small item. For an average biological treatment process, about 0.25 lbs of dried sludge must be disposed of for each person per day. For a community of 50,000, that means better than 6 tons per day must be dealt with.

A sludge management program can be a combination of treatment processes, ending in disposal. The various sludge treatment processes are designed to carry out one or more of the following: Volume reduction, solids reduction, conditioning, and stabilization.

The purpose of sludge volume reduction is to concentrate the sludge by separating some of the water from the sludge. After the sludge is concentrated, it can be further treated in less volume. The following processes are used primarily for sludge volume reduction.

VOLUME REDUCTION

*Gravity Thickening

Gravity thickening is similar to sedimentation in that the sludge is allowed to settle under the influence of gravity. Concentrated sludge is collected off the bottom and water is removed from the surface.

*Centrifugation

Centrifugation takes advantage of centrifugal force. As the sludge is spun in the centrifuge, the sludge is forced to the outside and the water removed near the center.

***Flotation Thickening** Flotation thickening separates the sludge from water by bubbling air into the sludge to decrease sludge density. With the air bubbles trapped in the sludge, it floats to the surface where it is scraped off. Water is removed from one end of the basin over a protected weir.

***Filtration Processes** Belt Filtration, Vacuum Filtration, Filter Pressing and Gravity Concentration are all devices that remove the water from the sludge with a filtering action. Some of these systems use a vacuum to suck the water through the filter and away from the sludge. Some squeeze the liquid out through a filter, as if in a wringer. Some squeeze the sludge into cakes between porous mats. The gravity concentration process uses gravity to pull water through a porous mat and away from the sludge. In all cases, the sludge becomes more concentrated, reducing the total volume.

SLUDGE IS CONCENTRATED

and . . .

VOLUME IS REDUCED

Drying Beds Heat can also be used to reduce sludge volume. Drying beds use heat from the ambient air or the sun to evaporate the water from the sludge. Low temperature heat can also be applied to speed the evaporation process. Underdrain systems are used to remove water that seeps out the bottom of the drying sludge.

CONDITIONING

***Enhances volume reduction**

A second major sludge treatment category is conditioning. Conditioning is defined as the pretreatment of sludge to enhance sludge volume reduction. The processes of gravity thickening, flotation thickening, vacuum filtration, centrifugation, drying beds and

filter presses, can all be made more efficient with sludge conditioning.

CONDITIONING METHODS

***Chemicals**

***Heat**

***Elutriation**

Sludges can be conditioned by the addition of chemicals, by heat or by elutriation. Organic polyelectrolytes as well as inorganic chemicals can be used to condition sludge. In the heat conditioning process, sludge is subject to high temperatures and pressures. In both processes, the chemical and physical structure of the sludge is altered in such a way as to make the removal of water easier. Elutriation conditions by a washing process which reduces chemical requirements and removes fine sludge particles.

STABILIZATION

. . . Reduces nusiances and health hazards

The primary purpose of stabilization is to make the sludge less odorous and putrescible and reduce pathogenic organism content. content.

***Lime**

***Chlorine**

The addition of lime to sludge in quantities sufficient to raise the pH to about 11.0, will stabilize the sludge and destroy pathogenic bacteria. Chlorine stabilizes by lowering the pH and by oxidation.

SOLIDS REDUCTION

***less to dispose of**

The last major sludge treatment category is sludge solids reduction. Several treatment processes result in a decrease in the suspended sludge solids. Reduction of solids present will, of course, mean that a smaller amount must be disposed of in the end.

***Anaerobic Digestion**
***Aerobic Digestion**

Both anaerobic and aerobic digestion result in sludge solids reductions.

The anaerobic process takes place in a covered vessel in which the oxygen-free anaerobic condition is maintained. Sludge is usually warmed and stirred as the anaerobic bacteria methabolize and reduce the solids content. Stabilization and sludge volume reduction also occur.

AEROBIC DIGESTION

The aerobic digestion process is similar to an activated sludge treatment process. It is an aerobic biological process carried out in an open basin. The aerobic bacteria metabolize and reduce the solids content. Stabilization and sludge volume reduction also occur with the aerobic process.

LAGOONS
***volume reduction**

Sludge lagoons can be utilized to reduce sludge solids. In biological processes similar to wastewater stabilization ponds, stored sludge can be metabolized and the solids content reduced. In addition, sludge volume reduction can also occur.

COMPOSTING
***solids reduction**
***solids stabilization**

Composting of sludges can result in a reduction of the sludge solids, as well as sludge stabilization. The total volume of composted material is greater than the original sludge volume, however, because bulking material is usually added to enhance aeration and digestion. The compost is allowed to digest for about two weeks, with occasional mixing.

ULTIMATE DISPOSAL

. . . the ultimate question!

Regardless of the type of conditioning, volume reduction, solids reduction or stabilization process used, there is still the problem of ultimate disposal of the treated sludge.

DISPOSAL

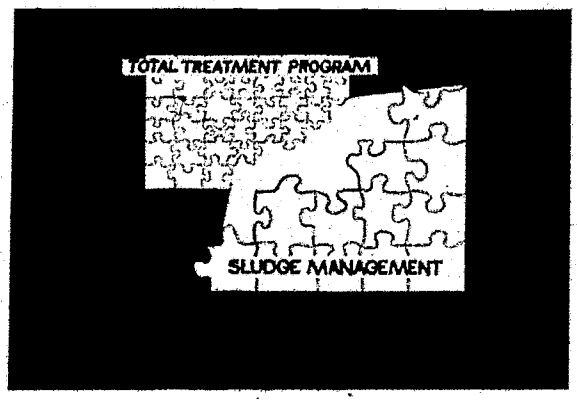
***Soil conditioner**

***Landfill**

***Incineration**

After treatment, sludge can be applied to land as a soil conditioner, it can be buried in landfill sites, or it can be reduced to ash by incineration. Land application is usually limited to agricultural crop land not used directly for food crops such as vegetables. Strict regulations govern its application. Sludge can be applied, whether on top of the soil, or the subsurface. Common solid waste landfills are often used as an ultimate disposal site. The major drawback to landfill is that no benefit is derived from the sludge. Incineration also destroys the sludge and is a high, energy requiring process.

SYSTEMS APPROACH



A sludge management program could be composed of different combinations of these processes. The decision of which processes to select must be made with many technical, social and economical factors taken into consideration. Whatever the choice, the "systems approach" must be the prime consideration. This means, simply, that the solids management program must be part of the system, and not be considered a separate entity or sideline.

From a technical standpoint, the type of waste being treated must be considered in the selection of the type of treatment and the type of equipment and facilities. The specific advantages and disadvantages of the various processes, from a technical viewpoint, and the equipment and facilities required for the various processes, are discussed in later modules.

SOCIAL IMPACT

ECONOMIC IMPACT

However, the sludge management program should not be selected on the basis of technical criteria alone. The sludge management program will have a significant social and economic impact on the community and it is important that criteria based on these social and economic impacts also be considered.

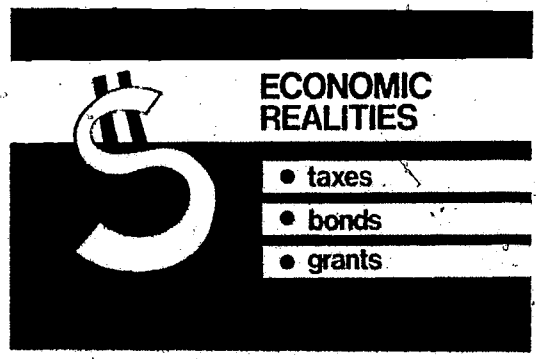
Social and economic criteria should include consideration of a number of items. Let's discuss each of these individually.

SITE AVAILABILITY

Site availability for the new system must be carefully considered. Location for the treatment units, as well as ultimate disposal locations, are important. Should the solids handling units be located at the treatment plant? Is ownership clear or must land be obtained? Location with respect to residential areas may be a problem.

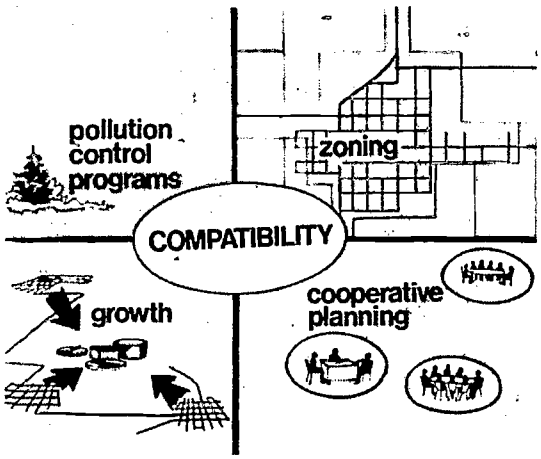
LEGAL?

The solids management program as a whole must, of course, be legal. A thorough understanding of the restrictions on ultimate disposal, air emission and water discharges is necessary.



The financing of the system must be assured. The sources of funding such as local tax, bonds, state and federal grants, should be investigated so that economic realities are clear during the selection process.

The new system should be compatible with existing programs such as land use planning and zoning, regional wastewater, solids and air pollution control programs and existing treatment facilities. Compatibility will insure greater acceptance of the system and usually be considerably more economical.



The economic impacts of a new system on a community can be both direct and indirect and have both a negative and a positive effect.

Direct negative effects would be cost of site acquisition and capital investment.

Indirect negative impact might be decreased land value near the site, loss of private property to plant site, or job loss due to incompatibility with existing industry or agriculture.

Direct positive impact can come from construction money to local contractors, payroll to operations personnel and sales of private land.

Indirect positive impact can come from construction and payroll monies affecting the economics of the entire community, recreational and commercial use of protected waterways, and increased land productivity due to solids application.

ECONOMIC BALANCE All of the economic factors should be considered in balance, as the various alternatives are reviewed.

ENERGY
***Direct**
***Indirect**

Energy demand and energy recovery is a serious social and economic concern. Direct energy demands include electric power, gas and oil consumption for operations of the facilities, as well as construction. Indirect energy demands include energy to produce chemicals and for transportation.

Some of the solids handling processes have energy recovery potential such as the production of natural gas in the anaerobic digestion process or the heat produced by incineration. The choice of process must balance energy demand with desired results.

PUBLIC HEALTH AND SAFETY

Public health and safety must be considered both during construction and later during normal operations. For example, would sludge trucks pass through residential areas or near schools? Landfill and land application areas must have restricted access because of potential health problems. The potential for contamination of potable water sources must be considered.

LAND APPLICATION . . . Good and Bad

Application of treated sludge onto land can have both adverse and beneficial effect on the soil. The productivity of soil can be improved by the chemical content of sludge applied to the land. However, some types of sludges contain chemicals which can change

pH values and nutrient balance in the soil and, in some cases, be toxic to vegetation and animals.

ECOLOGY

What about the plants and animals?

Some of the solids handling processes pose potential threats to water and air quality and to plant and animal life. If processes are located where leaching and runoff from lagoons, landfills, and composting can reach lakes and streams, water quality can be hurt.

Air quality becomes an issue with incineration and the other heat treatment processes.

WATER QUALITY

AIR QUALITY

Animal and plant life, both terrestrial and aquatic, can be adversely affected by reduced air and water quality near treatment facilities. Adverse effects on air, water, plants, and animals can be nearly eliminated by careful planning.

A solids handling program can have social effects on the community, both adverse and beneficial. If the community feels a need and a desire to protect the environment, the facility and program will be a source of civic pride. Added jobs, both directly and indirectly, can raise standards of living.

However, if the community is not involved in planning and if economics and social factors have not been considered, the community may be damaged by forcing acceptance of an unpopular program.

NEW RESPONSIBILITIES

***Administration**

Any new program will result in additional administrative responsibilities. Consideration should be given to handling public relations, resolution of legal disputes, and marketing problems. Processes that are compatible with existing administrative structure and require minimal change should be carefully considered.

CHANGES

***Staffing**

***Operations**

***Equipment**

***Maintenance**

There are several administrative functions that will change or increase. The new sludge handling program will mean changes in operational strategies and require additional staffing and rescheduling. Additional equipment and facilities will increase maintenance needs and, thus, cause changes in maintenance scheduling and staffing.

SAFETY

***training**

A major concern in the wastewater industry is in-plant safety. Safe operating procedures must be explained at special or regularly scheduled safety meetings. The use of new equipment must be demonstrated. New hazard signs and warning devices must be installed.

TRAINING NEEDS

***Upgrade present employees**

***New processes**

A new sludge management program will represent concepts and operational skills with which most of the operators are unfamiliar. Training must be provided for new employees and also to up-grade existing employees. An extensive initial training program may be needed to present fundamentals as well as explanations of the new processes.

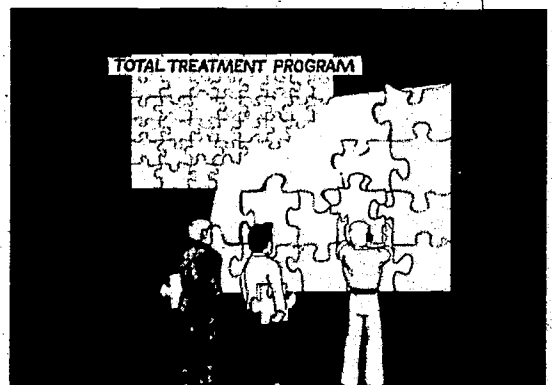
EMERGENCY PLANNING

*What happens when things break down?

A critical part of the sludge management program is a standby or emergency alternative sludge handling plan. The ability to treat and dispose of sludge is absolutely essential to continued operation of the rest of the treatment system. Therefore, in the event of a breakdown or other operational failure in the primary sludge handling system, an alternative must be available to temporarily handle sludge.

In summary, the criteria that should be considered in planning a sludge management program include social and economic considerations as well as technical feasibility.

SYSTEMS APPROACH



Planners must consider all criteria for process selection in developing the sludge management program, but must not lose sight of the systems approach to the total treatment program.

Putting together the sludge management program is a complex process which must involve planners, engineers, operators, legal advisors, and citizens. All criteria must be considered and evaluated so that each piece of the sludge management program will fit into the total picture.

REFERENCE:

Process Design Manual for Sludge Treatment and Disposal, U.S. EPA, EPA 625/1-79-011, Cincinnati, 1979.

PLANNING CONSIDERATIONS

WORKSHEET

1. Which of the following is NOT one of the three major types of solids found in wastewater treatment plants?

   _____ a. Suspended

   _____ b. Chemical

   _____ c. Raw

   _____ d. Biological

2. The "systems approach" to the design of a solids handling system means:

   _____ a. That a "systems analyst" using computer based design will always give the best results.

   _____ b. That the solids handling portion must be part of the overall waste treatment system.

   _____ c. That with any wastewater plant design, the approaching collection systems are the key issue.

3. Match the following examples with their appropriate social or economic criteria. (Some may have more than one answer.):

   _____ a. City owned land near existing plant

   _____ b. City zoning restrictions

   _____ c. Air quality restrictions near residential area

   _____ d. Sludge truck route on busy city streets

   _____ e. Federal cost sharing for capital construction

   _____ f. Regional water quality program applicable

   1. Site Availability
   2. Legal Consideration
   3. Financing Availability
   4. Compatibility With Other Programs
   5. Public Health and Safety

4. Match the following sludge handling processes with their function. (Some may have more than one function.):

_____ a. Anaerobic Digestion

_____ b. Elutriation

_____ c. Landfill

_____ d. Vacuum Filtration

_____ e. Heat Treatment

_____ f. Sludge Lagoon

_____ g. Composting

_____ h. Gravity Thickener

_____ i. Land Application

_____ j. Dissolved Air Flotation

_____ k. Belt Filter

_____ l. Chemical Treatment

_____ m. Lime Addition

_____ n. Filter Press

_____ o. Flotation Thickener

_____ p. Incineration

_____ q. Centrifugation

_____ r. Heat Drying

_____ s. Aerobic Digestion

_____ t. Drying Beds

_____ u. Chlorine Addition

_____ v. Gravity Concentration

1. Conditioning
2. Stabilization
3. Volume Reduction
4. Solids Reduction
5. Ultimate Disposal

5. Match as with #4 above.

_____ a. Decreased land value because of landfill location

_____ b. Payroll increase to community

_____ c. Boiler fired by heat from incinerator

_____ d. Power consumption use to run motors and lights

_____ e. Cost of land acquisition

_____ f. Power consumption used to produce chlorine

_____ g. Increase productivity of agricultural land because of land application

_____ h. Fuel required to haul sludge

1. Direct Cost
2. Indirect Cost
3. Direct Economic Benefit
4. Indirect Economic Benefit
5. Direct Energy Demand
6. Indirect Energy Demand
7. Energy Recovery

6. Match as with #'s 4 & 5 above.

_____ a. Citizen revolt because of "smelly" design

_____ b. "Conditioner" value of sludge from land application

_____ c. Leaching into stream from landfill

_____ d. Excessive stack discharge from incinerator

_____ e. Heavy toxic metals in land applied sludge

_____ f. New training program needed

_____ g. "Good feelings" due to keeping a clean environment

_____ h. Noxious fumes affecting vegetation and animal habitat

_____ i. Change in operation and scheduling

1. Adverse Effect on Soil
2. Beneficial Effect on Soil
3. Adverse Effect on Water Quality
4. Adverse Effect on Air Quality
5. Adverse Effect on Plant & Animal Life
6. Adverse Social Effect
7. Beneficial Social Effect
8. An Administrative Responsibility